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(54) **LASER DIFFERENTIAL CONFOCAL MAPPING-SPECTRUM MICROSCOPIC IMAGING METHOD AND DEVICE**

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See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,595,873 B1 9/2009 Deck
2006/0012871 A1 * 1/2006 Funk G01J 3/02 359/385

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1448707 A 10/2003
CN 1759307 A 4/2006

(Continued)

OTHER PUBLICATIONS

Kimberley F et al: "Description and Theory of a Fiber-Optic Confocal and Super-Focal Raman Microspectrometer", 1996.

(Continued)

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(57) **ABSTRACT**

The present invention belongs to a technical field of optical microscopic imaging and spectral measurement, and discloses a laser differential confocal mapping-spectrum microscopic imaging method and device. The core concept of the present invention is to combine the differential confocal detection and the spectrum detection techniques and use a dichroic beam splitting system (**13**) to separate the Rayleigh light for geometric position detection from the Raman scattering light for spectrum detection, by mean of the property that the zero-cross point of the differential confocal curve (**43**) accurately corresponds to the focus of the objective, the spectral information at focus of the excitation spot being accurately captured by the zero trigger to accomplish the spectrum detection with high spatial resolution. Therefore, the present invention provides a method and device that may be able to accomplish the spectrum detection with high spatial resolution to a micro-area of a sample.

16 Claims, 7 Drawing Sheets